EXHIBIT G

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF OHIO
EASTERN DIVISION

HYTERA COMMUNICATIONS CORP. LTD.	)	
Plaintiff,	)	Case No. 1:17-CV-01794-DCN
v.	)	Honorable Donald C. Nugent
MOTOROLA SOLUTIONS INC.,	)	Magistrate Judge William H. Baughman, Jr.
Defendant.	)	

EXPERT REPORT OF DAVID V. ANDERSON ON CLAIM CONSTRUCTION OF ASSERTED U.S. PATENT NO. 9,183,846

March 14, 2018

I. Introduction

I have been retained by the Defendant, Motorola Solutions, Inc. ("Motorola"), through their counsel—Kirkland & Ellis, LLP—to provide expert testimony in the matter of *Hytera Communications Corp. Ltd. v. Motorola Solutions Inc.*, Case No. 1:17-cv-01794-DCN, pending in the United States District Court for the Northern District of Ohio. It is my understanding that the parties are engaged in claim construction for U.S. Patent No. 9,183,846 ("the '846 patent" or "the Patent-in-Suit"). In this report, I address the construction of certain disputed claim terms and provide the bases for my opinions.

II. Background and Qualifications

I am currently a Professor in the School of Electrical & Computer Engineering at the Georgia Institute of Technology. I have been at Georgia Tech since 1999, becoming an Associate Professor in 2005 and a Professor in 2012. I regularly teach classes relating to Digital Signal Processing and Computer Engineering. I am being compensated for my time at my standard hourly rate of $400 per hour. My compensation does not depend on the outcome of this investigation or the opinions that I form.

I hold three degrees: a Bachelor of Science in Electrical Engineering from Brigham Young University, which I earned in 1993, a Master of Science in Electrical Engineering from Brigham Young University, which I earned in 1994, and a Ph.D. in Electrical and Computer Engineering from Georgia Tech, which I earned in 1999.

Much of my academic experience has been in signal processing. At Brigham Young, my coursework and research related to noise reduction and hearing-aid algorithms. At Georgia Tech, I continued research into noise reduction, digital signal processing of audio signals, and hearing aid applications for these technologies.

As a professor, I have published about 200 papers, most of which are related to audio processing. I have published one book on signal processing and have contributed significant portions of three other books on the subject. In addition, I have had 37 journal articles published since becoming a Professor, and I have had over one hundred and fifty conference papers published over my career. I am an inventor on seven patents. I am a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE) and a member of the IEEE Signal Processing Society. A more complete documentation of my experience is provided in my curriculum vitae (see Exhibit 1). I believe that I am highly qualified to provide testimony in this matter.

III. Documents and Other Information I Considered

In order to arrive at my opinions and conclusions concerning the construction of certain disputed terms of the Patent-in-Suit, I reviewed various documents. The following is a list of the documents upon which I have relied in forming my opinions, all of which are cited in the parties' preliminary claim constructions:

- Patent-in-Suit
- Patent-in-Suit file wrapper (HYTERA_000724)
- Motorola's Preliminary Claim Constructions pursuant to Local Patent Rules 4.2 (a) and (b), dated February 27, 2018
- Hytera's Preliminary Claim Constructions pursuant to Local Patent Rules 4.2 (a) and (b), dated February 27, 2018
- U.S. Patent No. 3,460,071 (MSI-1794-00686490)
- U.S. Patent No. 4,055,818 (MSI-1794-00686496)
- U.S. Patent No. 4,382,158 (MSI-1794-00686505)
- Joshua D. Reiss & Andrew P. McPherson, Audio Effects: Theory, Implementation and Application 90-91 (2014) (MSI-1794-00686433)
- Bruce Bartlett & Jenny Bartlett, Practical Recording Techniques 196-97 (5th ed. 2009) (MSI-1794-00686438)

- Audio Tone Control Using the TLC074 Operational Amplifier, Texas Instruments Application Report (2000) (MSI-1794-00686481)
- Definition of "*Voice Band*," www.telecomdictionary.com
- Definition of "*Audibility*," www.yourdictionary.com
- Definition of "*Audibility*," www.telecomdictionary.com

I may, if appropriate, cite these documents or any material referenced therein as additional support for any of my opinions beyond those expressly cited in this report. I reserve the right to amend and supplement my opinions, conclusions, and this report if and when I have the opportunity to analyze additional documents or information that may be made available to me, as well as based upon my own independent research. I further reserve the right to submit reports rebutting opinions that may be expressed in this case.

Any testimony that I provide in this matter concerning claim-construction will be based upon my background knowledge and experience relating to the topics discussed in my report, as well as the documents and things that I have considered in making this report. If I provide testimony at the claim-construction hearing, I may use some or all of the documents and information listed, mentioned, or described in this report—and materials prepared based on them—as exhibits to support or summarize my opinions. In addition, I may supplement these materials with other materials and charts to provide additional context, background, or information. In addition to the items that I have relied upon, or may rely upon in the future, I expect to use exemplary evidence, as identified above and elsewhere in this report, to present my opinions as set forth in this report.

IV. Legal Standards

In connection with the opinions and conclusions in this report, it is my understanding that some or all of the following legal rules, standards, or requirements may apply. I have applied these standards in my analysis of the Patent-in-Suit in order to arrive at my opinions.

A. Person of Ordinary Skill in the Art

I understand that a person of ordinary skill in the art (a "POSITA") is a hypothetical person who is presumed to have known the relevant art at the time of the invention, and that the factors that may be considered in determining the level of ordinary skill in the art may include: (a) type of problems encountered in the art; (b) prior art solutions to those problems; (c) rapidity with which innovations are made; (d) sophistication of the technology; and (e) educational level of active workers in the field. In a given case, every factor may not be present, and one or more factors may predominate. I also understand that the hypothetical person having ordinary skill in the art to which the claimed subject matter pertains would, of necessity, have the capability of understanding the scientific and engineering principles applicable to the pertinent art, and moreover, is a person of ordinary creativity, not an "automaton."

Although the time of invention based on the face of the '846 patent is May 29, 2014, it is my understanding that Hytera claims an earlier invention date of November 19, 2010. While I reserve my right to opine on whether the '846 patent was conceived of and reduced to practice by that date, I have been told to assume that that date is the invention date of the '846 patent.

Based upon my experience and personal knowledge, a POSITA for the Patent-in-Suit would have had at least a Bachelor's degree in Electrical Engineering, Computer Engineering, or Computer Science, with at least two to three years of experience in signal processing and/or communications, or an equivalent degree and/or experience. Superior education would compensate for a deficiency in experience, and vice versa.

B. Claim Construction

I understand that, although claim language defines the legal scope of a patent, the primary source of evidence for claim construction is the entire body of intrinsic evidence (*i.e.*, the patent itself, including the claims, the specification, and the prosecution history). I further understand that the words used in a claim are generally given their ordinary and customary meaning, which is the meaning to the ordinary artisan after reading the entire patent. The patent's specification is the single best guide to the meaning of a disputed term, and usually is dispositive on claim construction.

V. Claim Construction of the Patent-in-Suit

A. Overview of Patent-in-Suit

The Patent-in-Suit is directed towards "[a] method for adaptively adjusting an acoustic effect and an apparatus thereof." ('846 patent at Abstract, 1:66-67.) The Patent-in-Suit has a total of six (6) asserted claims.

B. U.S. Patent No. 9,183,846

1. "an energy value"

Based on my years of experience, a POSITA reading the '846 patent in light of the specification and the file history would have understood the claim term "an energy value" to mean: "a single energy value." This construction is consistent with and supported by a plain reading of the claim language and all of the intrinsic evidence. (*See, e.g.*, '846 patent at Abstract, Figures 1 and 2, Claim 1, 2:9-19, 3:10-24, 5:8-38, 8:31-33, 8:45-47, 9:1-3, 9:13-19, 9:24-31, 9:37-46, 10:45-46, 11:20-40, 11:44-58; File Wrapper of '846 Patent, Notice of Allowability.)

For example, a POSITA would have understood that a reference to "energy value" in which "value" is singular and in which "energy value" is preceded by the indefinite article "an," followed by subsequent references to "the energy value" means that "an energy value" refers to a ***single***

energy value. (*See, e.g.*, '846 patent at Abstract, Figures 1 and 2, Claim 1, 2:9-19, 3:10-24, 5:8-38, 8:31-33, 8:45-47, 9:1-3, 9:13-19, 9:24-31, 9:37-46, 10:45-46, 11:20-40, 11:44-58; File Wrapper of '846 Patent, Notice of Allowability.) A POSITA reading the '846 patent would also have observed that in each instance in which the patent refers to "energy value," it is referring to a ***single*** value. (*See, e.g.*, '846 patent at Abstract, Figures 1 and 2, Claim 1, 2:9-19, 3:10-24, 5:8-38, 8:31-33, 8:45-47, 9:1-3, 9:13-19, 9:24-31, 9:37-46, 10:45-46, 11:20-40, 11:44-58.) In the context of a single claim, reference to "the energy value" would therefore in each case refer to that *same* "energy value." (*See, e.g.*, *id.* at Abstract, Figures 1 and 2, Claim 1, 2:9-19, 3:10-24, 5:8-38, 8:31-33, 8:45-47, 9:1-3, 9:13-19, 9:24-31, 9:37-46, 10:45-46, 11:20-40, 11:44-58.)

2. "treble boost [processing]"[1]

Based on my years of experience, a POSITA reading the '846 patent in light of the specification and the file history would have understood the claim term "treble boost" to mean: "an amplification of all treble frequencies using a gain greater than 1." This construction is consistent with and supported by a plain reading of the claim language and all of the intrinsic evidence. (*See, e.g.*, '846 patent at Abstract, Figure 5, 1:28-40, 2:9-19, 3:10-24, 4:38-40, 5:13-22, 10:50-11:13, 11:44-58; File Wrapper of '846 Patent, Notice of Allowability.)

For example, the '846 patent explains what a "treble boost" is with reference to Figure 5, which a POSITA would understand to depict all treble frequencies being amplified using a gain greater than 1. (*See* '846 patent at Figure 5, 10:50-11:13.) Figure 5 of the '846 patent is a graph depicting the amplitude response in dB of frequencies during a "treble boost." (*Id.* at Figure 5,

[1] I understand that Motorola proposes to construe "treble boost" and "bass boost," and Hytera proposes to construe "treble boost processing" and "bass boost processing." I do not believe it is necessary to construe the relatively longer terms proposed by Hytera, but in any event, my opinions do not depend on which of these two sets of phrases may ultimately be construed in this matter.

4:38-40.) A POSITA would understand Figure 5 to indicate that during a "treble boost," the amplitude of treble frequencies is increased by a factor greater than 1 (*i.e.*, to values greater than 0 dB), as reflected in Motorola's proposed construction. (*Id.*) Furthermore, a POSITA would understand that the attenuated frequencies and the frequencies receiving no gain in Figure 5 are not treble frequencies. (*See, e.g.*, *id.* Figure 5, 4:38-40, 10:50-11:13; File Wrapper of '846 Patent, Notice of Allowability.)

In addition to the intrinsic evidence, Motorola's proposed construction of "treble boost" is also consistent with and supported by extrinsic evidence that predates or is contemporaneous with the '846 patent. (*See, e.g.*, U.S. Patent No. 3,460,071 at 1:35-55 (explaining that emphasizing the signal level of treble frequencies to a level higher than the signal level of mid-range frequencies is boosting); U.S. Patent No. 4,055,818 at Figure 3, 1:8-19, 3:37-40, 4:40-52, 6:3-9 (explaining that treble boosting is increasing high frequency response with respect to middle and low frequencies); U.S. Patent No. 4,382,158 at 2:6-7, 3:46-64, 6:6-17 (explaining how to boost treble frequencies); Joshua D. Reiss & Andrew P. McPherson, Audio Effects: Theory, Implementation and Application 90-91 (2014) (depicting frequency response for treble boost); Bruce Bartlett & Jenny Bartlett, Practical Recording Techniques 196-97 (5th ed. 2009) (depicting frequency response for treble boost); Audio Tone Control Using the TLC074 Operational Amplifier, Texas Instruments Application Report 2-3, 5-7 (2000) (depicting frequency response for treble boost).) Indeed, several references include amplitude response curves depicting a "treble boost" that is very similar to Figure 5 of the '846 patent, each showing increased amplitude of treble frequencies by a factor greater than 1 with respect to other frequencies on the spectrum. (*See, e.g.*, U.S. Patent No. 3,460,071 at 1:35-55; U.S. Patent 4,055,818 at Figure 3, 1:8-19, 3:37-40, 4:40-52, 6:3-9; Joshua D. Reiss & Andrew P. McPherson, Audio Effects: Theory, Implementation and Application 90-91

(2014); Bruce Bartlett & Jenny Bartlett, Practical Recording Techniques 196-97 (5th ed. 2009); Audio Tone Control Using the TLC074 Operational Amplifier, Texas Instruments Application Report 2-3, 5-7 (2000).)

I understand that Hytera proposes to construe "treble boost processing" to mean "an automatic adjustment that results in increased audibility of high frequencies in the voice band of the current output." (Hytera's Preliminary Claim Constructions pursuant to Local Patent Rules 4.2 (a) and (b), dated February 27, 2018.) In my opinion, this proposed construction is incorrect because it is not supported by the intrinsic record or by the understanding of a POSITA, as discussed above. (*See, e.g.*, '846 patent at Abstract, Figure 5, 1:28-40, 2:9-19, 3:10-24, 4:38-40, 5:13-22, 10:50-11:13, 11:44-58; File Wrapper of '846 Patent, Notice of Allowability.)

3. "bass boost [processing]"

Based on my years of experience, a POSITA reading the '846 Patent in light of the specification and the file history would have understood the claim term "bass boost" to mean: "an amplification of all bass frequencies using a gain greater than 1." This construction is consistent with and supported by a plain reading of the claim language and all of the intrinsic evidence. (*See, e.g.*, '846 patent at Abstract, Figure 6, 1:28-40, 2:9-19, 3:10-24, 4:41-43, 5:13-17, 5:22-26, 10:50-11:13, 11:44-58; File Wrapper of '846 Patent, Notice of Allowability.)

For example, the '846 patent explains what a "bass boost" is with reference to Figure 6, which a POSITA would understand to depict all bass frequencies being amplified using a gain greater than 1. (*See* '846 patent at Figure 6, 10:50-11:13.) Figure 6 of the '846 patent is a graph depicting the amplitude response in dB of frequencies during a "bass boost." (*Id.* at Figure 6, 4:41-43.) A POSITA would understand Figure 6 to indicate that during a "bass boost," the amplitude of bass frequencies is increased by a factor greater than 1 (*i.e.*, to values greater than 0 dB), as

reflected in Motorola's proposed construction. (*Id.*) Furthermore, a POSITA would understand that the attenuated frequencies and the frequencies receiving no gain in Figure 6 are not bass frequencies. (*See, e.g., id.* at Figure 6, 4:41-43, 10:50-11:13; File Wrapper of '846 Patent, Notice of Allowability.)

In addition to the intrinsic evidence, Motorola's proposed construction of "bass boost" is also consistent with and supported by extrinsic evidence that predates or is contemporaneous with the '846 patent. (*See, e.g.*, U.S. Patent No. 3,460,071 at 1:35-55 (explaining that emphasizing the signal level of bass frequencies to a level higher than the signal level of mid-range frequencies is boosting); U.S. Patent No. 4,055,818 at Figure 3, 1:8-19, 3:37-40, 4:40-52, 6:3-9 (explaining that bass boosting is increasing low frequency response with respect to the middle and high frequencies); U.S. Patent No. 4,382,158 at 2:6-7, 3:46-64, 6:6-17 (explaining how to boost bass frequencies); Joshua D. Reiss & Andrew P. McPherson, Audio Effects: Theory, Implementation and Application 90-91 (2014) (depicting frequency response for bass boost); Bruce Bartlett & Jenny Bartlett, Practical Recording Techniques 196-97 (5th ed. 2009) (depicting frequency response for bass boost); Audio Tone Control Using the TLC074 Operational Amplifier, Texas Instruments Application Report 2-3, 5-7 (2000) (depicting frequency response for bass boost).) Indeed, several references include amplitude response curves depicting a "bass boost" that is very similar to Figure 6 of the '846 patent, each showing increased amplitude of bass frequencies by a factor greater than 1 with respect to other frequencies on the spectrum. (*See, e.g.*, U.S. Patent No. 3,460,071 at 1:35-55; U.S. Patent 4,055,818 at Figure 3, 1:8-19, 3:37-40, 4:40-52, 6:3-9; Joshua D. Reiss & Andrew P. McPherson, Audio Effects: Theory, Implementation and Application 90-91 (2014); Bruce Bartlett & Jenny Bartlett, Practical Recording Techniques 196-97 (5th ed. 2009);

Audio Tone Control Using the TLC074 Operational Amplifier, Texas Instruments Application Report 2-3, 5-7 (2000).)

I understand that Hytera proposes to construe "bass boost processing" to mean "an automatic adjustment that results in increased audibility of low frequencies in the voice band of the current output." (Hytera's Preliminary Claim Constructions pursuant to Local Patent Rules 4.2 (a) and (b), dated February 27, 2018.) In my opinion, this proposed construction is incorrect because it is not supported by the intrinsic record or by the understanding of a POSITA, as discussed above. (*See*, *e.g.*, '846 patent at Abstract, Figure 6, 1:28-40, 2:9-19, 3:10-24, 4:41-43, 5:13-17, 5:22-26, 10:50-11:13, 11:44-58; File Wrapper of '846 Patent, Notice of Allowability.)

VI. Conclusion

For the foregoing reasons, it is my opinion that the claim constructions proposed by Motorola are proper.

Respectfully Submitted,

David V. Anderson, Ph.D.

Date: March 14, 2018

EXHIBIT 1

School of Electrical and Computer Engineering
Georgia Institute of Technology
770-883-0708
anderson@gatech.edu

David V. Anderson

Earned Degrees

1999 **Ph.D. in Electrical and Computer Engineering**.
Georgia Institute of Technology

1994 **M.S. in Electrical Engineering**.
Brigham Young University

1993 **B.S. in Electrical Engineering**.
Brigham Young University

Employment

2012-present **Professor**, *School of Electrical & Computer Engineering*, Georgia Institute of Technology, Atlanta, Georgia.

2011–present **Partner**, *Ratrix Technologies, LLC*, Atlanta, Georgia.
High-tech start-up with NSF SBIR funding to develop wireless data receivers

2005-2012 **Associate Professor**, *School of Electrical & Computer Engineering*, Georgia Institute of Technology, Atlanta, Georgia.

2009 **Visiting Professor**, *Department of Computer Science*, Korea University, Seoul, South Korea.

1999-2005 **Assistant Professor**, *School of Electrical & Computer Engineering*, Georgia Institute of Technology, Atlanta, Georgia.

1999 **Education Specialist**, *Texas Instruments, Inc.*, Dallas, Texas.

Professional Service

2014-2015 Chair, Computer Systems and Software area in Electrical and Computer Engineering, Georgia Institute of Technology

2014 Treasurer, IEEE Global Conference on Signal and Information Processing (GlobalSIP)

2011–present ECE Advisory Board, Rose-Hulman Institute of Technology

2011-2014 Chair, Institute Faculty Status Grievance Committee, Georgia Institute of Technology

2010–present Member, Institute Faculty Status Grievance Committee, Georgia Institute of Technology

2010 Technical Area Chair for the Asilomar Conference on Signals, Systems, and Computers

2009-2014 Member, ECE Graduate Student Recruiting Committee, Georgia Institute of Technology

2006–2007	Associate Director, Center for Research in Embedded Systems Technology
2005–2008	Member, Institute Graduate Committee, Georgia Institute of Technology
2005-2008	Member, Georgia Tech Faculty Senate, Georgia Institute of Technology
2004–2007	Associate Director over Education Outreach for the Center for Research on Embedded Systems (CREST)
2003	Co-Chair for the NSF Symposium on Next Generation Automatic Speech Recognition
2002	Local Arrangements Chair for the DSP Workshop
2002	Local Arrangements Chair for the Signal Processing Education Workshop
2001–2009	Member, ECE Graduate Committee, Georgia Institute of Technology
2000	Technical Co-Chair for Signal Processing Education Workshop
1999–2001	Member, ECE Computing Committee, Georgia Institute of Technology
1999–present	Reviewer for numerous journals and conference publications

Consulting

2017–present	Expert witness for Motorola Solutions, Inc, represented by Kirkland and Ellis, LLC in *Hytera Communications Corp. Ltd. v. Motorola Solutions Inc.*, No. 1:17-cv-01794 (Northern District of Ohio)
2017–present	Expert witness for III Holdings, represented by Posinelli LLP in IPR K/S HIMPP et al. v. III Holdings
2017–2018	Expert witness for Motorola Solutions, Inc, represented by Kirkland and Ellis, LLC in *In the Matter of Certain Two-Way Radio Equipment and Systems, Related Software and Components Thereof* before the International Trade Commission, Investigation No. 337-TA-1053
2017–2018	Expert witness for St. Lawrence Communications LLC, represented by AZA Law LLC in *Saint Lawrence Communications LCC v. Apple Inc., AT&T Mobility, and Cellco Partnership D/B/A Verizon Wireless Civil Action No. 2:16-cv-00082-JRG (Eastern District of Texas)*
2016–2017	Expert witness for Samsung Corporation, represented by Covington Burlington, LLP in *In the Matter of Certain Audio Processing Hardware, Software, and Products Containing the Same* before the International Trade Commission, Investigation No. 337-TA-1026
2016–2017	Expert consultant for Alston and Bird, LLC on behalf of Nokia.
2015–2016	Expert witness for Acer, Inc.; Acer America Corp.; ASUS TeK Computer Inc.; ASUS Computer International; Dell Inc.; Hewlett Packard Co.; Lenovo Holding Co., Inc.; Lenovo (United States) Inc.; Toshiba Corp.; and Toshiba America Information Systems, Inc. in *In the matter of certain audio processing hardware and software products contain same* before the International Trade Commission, case 337-TA-949 (deposed)

2015 Expert witness for Realtek Semiconductor Corporation, represented by Steptoe & Johnson, LLP in *Realtek Semiconductor Corporation v. Andrea Electronics Corporation before the United States Patent and Trademark Office Patent Trial and Appeal Board*, Case Numbers IPR2015-01392, IPR2015-01393, IPR2015-01394, IPR2015-01395, IPR2015-01396

2015 Expert witness for Realtek Semiconductor Corporation, represented by Chen Malin, LLP in *In the matter of certain audio processing hardware and software products contain same* before the International Trade Commission, case 337-TA-949

2012–2013 Expert witness for MobileMedia Ideas, LLC, represented by Proskauer in *MobileMedia Ideas LLC, v. Research in Motion Limited and Research in Motion Corporation, Civil Action No. 3:11-cv-02353-N (Northern District of Texas)* (deposed)

2009-2013 Expert witness for Oticon, LLC, represented by Birch, Steward, Kolasch, & Birch, L.L.P. in *Oticon, Inc. v. Sebotek Hearing systems, LLC, et al., Civil Action No. 3:08-cv-05489-FLW (District of New Jersey)* and *Sound Design Technologies, Ltd. v Oticon, Inc., Civil Action No. 2:11-cv-01375-SRB (District of Arizona)* (deposed twice, testified in Markman hearing)

2007-2011 Expert Consultant, Alston and Bird, LLC performing internal analysis for various Nokia Patents

2011 Expert consultant for Alston and Bird, LLC on behalf of Nokia in *Nokia Corporation v. Apple Inc., Civil Action No. 1:09-cv-00791-GMS (District of Delaware)*

2011 Expert witness for Flightcom Corporation, represented by Alston and Bird, LLC in *TechnoFirst S.A. v. Flightcom Corp., Civil Action No. 2:05-cv-00411-HCM-FBS (Eastern District of Virginia)*

2011 Expert consultant for Alston and Bird, LLC on behalf of Nokia in *Nokia Corporation v. Apple Inc., Civil Action No. 1:09-cv-00791-GMS (District of Delaware)* (patent analysis)

2008 Technical Consultant, Sound Innovations, Inc., White River Junction, Vermont

2007-2008 Expert witness for Oticon, LLC and Bernafon, represented by Finnegan and Henderson in *Energy Transportation Group, Inc, v. Sonic Innovations, Inc., et al, Case 1:05-cv-00422-GMS (District of Delaware)* (non-infringement expert, deposed, testified before jury)

2007–2008 Technical Consultant, Personics Labs, Boca Raton, Florida

2005–2008 Technical Consulant and Technical Advisory Board member, GTronix, Inc., Fremont, California

1998–2000 Technical Consultant, ASPI, Inc., Atlanta, Georgia

Community Involvement (selected)

2012–2016 President, Waters Mill Home Owners Association

2006–2015 Judge for the Georgia FIRST Lego League State Championships robotics competition for middle school students

2005–present Assistant Scoutmaster, Merit Badge Counselor, and Woodbadge recipient, Boy Scouts of America

1987-1989 LDS Mission Service in Tempe Arizona

Honors and Awards (selected)

2004 Presidential Early Career Award for Scientists and Engineers (PECASE)

2004 NSF Faculty Early Career Development (CAREER) Award

2006 US Frontiers of Engineering Fellow, National Academy of Engineering

2006 Frontiers of Science Fellow, National Academy of Science

2009 Nominated by the School of Electrical and Computer Engineering for the Institute 2009 Outstanding Faculty Leadership Award for the Development of Graduate Research Assistants

Memberships

1991–present Senior Member IEEE (Institute of Electrical and Electronics Engineers)
Member IEEE Signal Processing Society
Member IEEE Education Society
Member IEEE Communications Society

1994–present Member ASA (Acoustical Society of America)

Teaching—Ph.D. Students Graduated

2004 **Tyson S. Hall, Ph.D.**
Thesis: Field–Programmable Analog Arrays: A Floating–Gate Approach
Current: Professor at Southern Adventist University

2005 **Heejong Yoo, Ph.D.**
Thesis: Low–Power Audio Input Enhancements for Portable Devices
Current: IP department at Qualcomm, Inc.

2005 **Venkatesh Krishnan, Ph.D.**
Thesis: A framework for low bit-rate speech coding in noisy environments
Current: Multimedia research group at Qualcomm, Inc.

2006 **Cenk Demiroglu, Ph.D.**
Thesis: Multisensor Segmentation-based Noise Suppression for Intelligibility Improvement in MELP Coders
Current: Assistant Professor at Özyeğin University (Turkey)

2006 **Rongqiang (James) Hu, Ph.D.**

Thesis: Multi-Sensor Noise Suppression and Bandwidth Extension for Enhancement of Speech

Current: Nintendo

2007 **Sourabh Ravindran, Ph.D.**

Thesis: Physiologically Motivated Methods for Audio Pattern Classification

Current: Director, Mobile Processor Innovation Lab at Samsung

2007 **Shyam Subramanian, Ph.D.**

Thesis: Methods for Synthesis of Multiple-Input Translinear Element Networks

Current: Senior Principal Design Engineer at Cadence Design Systems

2007 **Teahyung Lee, Ph.D.**

Thesis: Algorithm-based Efficient Approaches for Motion Estimation Systems

Current: Intel Research

2009 **Nikolaos Vasiloglou, Ph.D.**

Thesis: Isometry and Convexity in Dimensionality Reduction

Current: Entreprenuer and Consultant in Machine Learning

2009 **Haw Jing (Michael) Lo, Ph.D.**

Thesis: Design of a Reusable Distributed Arithmetic Filter and its Application to the Affine Projection Algorithm

Current: Qualcomm, Inc.

2009 **Ismail Faik Baskaya, Ph.D.**

Thesis: Physical Design Automation for Large Scale Field Programmable Analog Arrays

Current: Assistant Professor at Boğaziçi University, Istanbul (Turkey)

2009 **Walter Huang, Ph.D.**

Thesis: Implementation of Adaptive Digital FIR and Reprogrammable Mixed-Signal Filters using Distributed Arithmetic

Current: Qualcomm, Inc.

2009 **Jungwon Lee, Ph.D.**

Thesis: Efficient Image Compression System with a CMOS Transform Imager

Current: Senior Engineer, Samsung Electronics, Korea

2009 **Harry (Bo) Marr, Ph.D.**

Co-advisor: Jennifer Hasler

Thesis: Learning, Probabilistic, and Asynchronous Technologies for an Ultra Efficient Datapath

Current: Director of Low Power Computing Group Raytheon at Raytheon, Inc.

2011 **Brian Gestner, Ph.D.**

Thesis: Lattice Reduction for MIMO Detection: From Theoretical Analysis to Hardware Realization

Current: Chief Technology Officer at Soneter

2012 **Jason George, Ph.D.**

Thesis: Harnessing Resilience: Biased Voltage Overscaling for Probabilistic Signal Processing

Current: Entrepreneur

2012 **Leung Kin Chui, Ph.D.**

Thesis: Efficient audio signal processing for embedded systems

Current: Design Engineer at Texas Instruments

2012 **Jorge Marin, Ph.D.**

Thesis: Robust binaural noise-reduction strategies with binaural-hearing-aid constraints: design, analysis and practical considerations

Current: Professor at Universidad del Quindío

2012 **Devangi Parikh, Ph.D.**

Thesis: Improving the quality of speech in noisy environments

Current: Biomedical Research Lab at Texas Instruments

2012 **Varinthira Duangudom, Ph.D.**

Thesis: Computational auditory saliency

Current: Homemaker

2013 **Irteza Syed, Ph.D.**

Thesis: Classifiation using Residual Vector Quantization

Current: Aero, Inc, Pakistan

2014 **Syed Hussain Raza, Ph.D.**

Thesis: Temporally Consistent Semantic Segmentation in Videos

Current: NVIDIA

2014 **Nashie Sephus, Ph.D.**

Thesis: A Framework for Exploiting Modulation Spectral Features in Music Data Mining and Other Applicaitons

Current: CTO at Partpic, Inc.

2015 **Ryan Curtin, Ph.D.**

Thesis: Improving Dual-Tree Algorithms

Current: Symantec

2015 **Chu Meh Chu, Ph.D.**

Thesis: Exploiting Temporal and Spatial Redundancies for Vector Quantization of Speech and Images

Current: Georgia Perimeter College

2016 **Jinwoo Kang, Ph.D.**

Thesis: Face Recognition for Vehicle Personalization

2017 **Kaitlin Fair, Ph.D.**

Thesis: A Biologically Plausible Sparse Approximation Solver on Neuromorphic Hardware

Current: Air Force Research Lab

2017 **Muhammed Rizwan, Ph.D.**

Thesis: Adaptation of Hybrid Deep Neural Network–Hidden Markov Model Speech Recognition System using a Sub-space Approach

Current: Assistant Professor in Pakistan

Teaching—Current Ph.D. Students

2006–present **Nathan Parrish**—Passed Prelimin Exam: 2007. Proposal completed 2014. Thesis area: Particle Filters for Tracking Tongue Movements via Magnetic Sensors. *Currently working and attending school part-time.*

2012–present **Brandon Carroll**—Passed Prelimin Exam: 2012. Proposal completed 2015. Thesis area: Frozen Dictionary Based Disease Detection and Dictionary Based Novelty Detection for Automated Poultry Monitoring

2013–present **Bradley Whitaker**—Passed Prelimin Exam: 2013. Proposal submitted 2016. Thesis area: Sparse Dictionaries for Anomaly Detection

2015–present **Babafemi Odelowo**—Passed Prelim Exam. Proposal completed 2016. Thesis area: Speech Enhancement

2015–present **Chieh-Feng Cheng**—Passed Prelim Exam 2015. Thesis area: Activity Detection Using Audio

2016–present **Lee Richert**—Passed Prelim Exam 2015. Thesis area: Sparse Signal Modeling

2016–present **You Wang**—Passed Prelim Exam 2016.

2017–present **Chuyao Feng**—Passed Prelim Exam 2016.

Masters Thesis Students Graduated

2002 **Hyung K. Choi**
Thesis: Blind Source Separation of the Audio Signals in a Real World

2003 **Paul Hultz**
Thesis: Backward Masking in the Human Auditory System

2006 **Daniel Allred**
Thesis: Evaluation and Comparison of Beamforming Algorithms for Microphone Array Speech Processing

2012 **Ailar Javadi**
Thesis: Bio-inspired noise robust auditory features

2012 **Guillermo Colón**
Thesis: Avian musing feature space analysis

2016 **Tushar Supe**
Thesis: Super–CORDIC: Low Delay CORDIC Architectures for Computing Complex Functions

B.2.b. M.S. Students in Progress (with Thesis)

2016–present **Jonathon Austin**. Thesis: Distributed Sparse Dictionary Learning

Scholarly Accomplishments

Published Books

Wayne T. Padgett and David V. Anderson. *Fixed-point Signal Processing*. Synthesis Lectures on Signal Processing. Morgan & Claypool Publishers, 2009.

Published Parts of Books

J. H. McClellan, R. W. Schafer, and M. A. Yoder. *DSP First: A Multimedia Approach*. Prentice Hall, 1998. Assisted in the preparation of the multi-media CD-ROM that accompanies the text. Wrote and revised the laboratory projects included in the text.

Sheng-Yu Peng, Paul E. Hasler, and David Anderson. An analog programmable multi-dimensional radial basis function based classifier. In *IFIP WG 10.5 International Conference on Very Large Scale Integration of System-on-Chip*, pages 13–18, Atlanta, GA, October 2007.

Jorge Marin-Hurtado and David V. Anderson. *Independent Component Analysis for Audio and Biosignal applications*, chapter Preservation of Localization Cues in BSS-Based Noise Reduction: Application in Binaural Hearing Aids. InTech, 2012. Ganesh R Naik, ed.

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Paul Hasler, Abhishek Bandyopadhyay, and David V. Anderson. High fill–factor imagers for neuromorphic processing enabled by floating–gate circuits. *EURASIP Journal on Applied Signal Processing*, 2003(7):676–689, June 2003. Invited paper for special issue on neuromorphic signal processing and implementation.

Venkatesh Krishnan and David V. Anderson. Joint design of channel–optimized multistage vector quantizer. *IEEE Signal Processing Letters*, 11(1):5–7, January 2004.

Venkatesh Krishnan, David V. Anderson, and Kwan Truong. Optimal multistage vector quantization of LPC parameters over noisy channels. *IEEE Transactions on Speech and Audio Processing*, 12(1):1–8, January 2004.

Paul S. Hong, David V. Anderson, Doug B. Williams, Thomas P. Barnwell III Joel R. Jackson, Monson H. Hayes III, Ronald W. Schafer, and John D. Echard. "DSP for practicing engineers:" A case study in internet course delivery. *IEEE Transactions on Education*, 47(3):301–310, August 2004.

Abhishek Bandyopadhyay, Paul Hasler, and David V. Anderson. A CMOS floating–gate matrix transform imager. *IEEE Sensors*, 5(3):455–462, 2005.

Paul Hasler, Paul D. Smith, Rich Ellis, David Graham, and David Anderson. Analog floating–gate, on–chip auditory sensing system interfaces. *IEEE Sensors*, 5:1027–1034, October 2005.

Sourabh Ravindran, Kristopher Schlemmer, and David V. Anderson. A physiologically inspired method for audio classification. *EURASIP Journal on Applied Signal Processing*, 2005(9):1374–1381, 2005.

Tyson S. Hall, Christopher M. Twigg, Paul Hasler, and David V. Anderson. Developing large–scale field–programmable analog arrays for rapid prototyping. *International Journal for Embedded Systems*, 1(3/4):179–192, 2005.

Sourabh Ravindran, Paul Smith, David Graham, Varinthira Duangudom, David Anderson, and Paul Hasler. Towards biologically inspired on–chip auditory processing. *EURASIP Journal on Applied Signal Processing*, 2005(7):1082–1092, 2005.

Daniel J. Allred, David V. Anderson, Walter Huang, Venkatesh Krishnan, and Heejong Yoo. LMS adaptive filters using distributed arithmetic for high throughput. *IEEE Transactions on Circuits and Systems*, 52(7):1327–1337, July 2005.

Tyson S. Hall and David V. Anderson. A framework for teaching real-time digital signal processing with field-programmable gate arrays. *IEEE Transactions on Education*, 48(3):551 – 558, August 2005.

Tyson S. Hall, Christopher M. Twigg, Jordan D. Gray, Paul Hasler, and David V. Anderson. Large–scale field–programmable analog arrays for analog

signal processing. *IEEE Transactions on Circuits and Systems*, 52(11):2298 – 2307, November 2005.

Faik Baskaya, Sasank Reddy, Sung Kyu Lim, and David V. Anderson. Placement for large-scale floating-gate field programable analog arrays. *IEEE Transactions on Very Large Scale Integration Systems*, 14(8):906–910, August 2006.

Sheng-Yu Peng, Paul Hasler, and David V. Anderson. An analog programmable multi-dimensional radial basis function based classifier. *IEEE Transactions on Circuits and Systems I*, 54(10):2148–2158, October 2007.

Erhan Ozalevli, Walter Huang, Paul E. Hasler, and David V. Anderson. A reconfigurable mixed-signal VLSI implementation of distributed arithmetic used for finite-impulse response filtering. *IEEE Transactions on Circuits and Systems I*, 55(2):510–521, March 2008.

Kofi M. Odame, David V. Anderson, and Paul Hasler. A bandpass filter for inherent gain adaptation for hearing applications. *IEEE Transactions on Circuits and Systems I*, 55(3):786–795, April 2008.

Wei Zhang, Xiaoli Ma, Brian Gestner, and David V. Anderson. Designing low-complexity equalizers for wireless systems. *IEEE Communications Magazine*, 47(1):56–62, January 2009.

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L.J. Karam, I. Alkamal, A. Gatherer, G.A. Frantz, D.V. Anderson, and B.L. Evans. Trends in multicore DSP platforms. *IEEE Signal Processing Magazine*, 26(6):38–49, November 2009.

Bo Marr, Jason George, Brian Degnan, David V. Anderson, and Paul E. Hasler. Error immune logic for low power probabilistic computing. *VLSI Design*, 2010. doi:10.1155/2010/460312.

Walter Huang and David V. Anderson. Modified sliding-block distributed arithmetic with offset binary coding for adaptive filters. *Journal of Signal Processing Systems*, April 2010. Available: http://dx.doi.org/10.1007/s11265-010-0479-4.

David V. Anderson. Storytelling—the missing art in engineering presentations. *IEEE Signal Processing Magazine*, 28(2):109–111, March 2011.

Brian Gestner, Wei Zhang, Xiaoli Ma, and David V. Anderson. Lattice reduction for MIMO detection: From theoretical analysis to hardware realization. *IEEE Transactions on Circuits and Systems I*, 58(4):813 –826, April 2011.

J. Marin Hurtado and David V. Anderson. FFT-based block processing in speech enhancement: Potential artifacts and solutions. *IEEE Transactions on Audio, Speech and Language Processing*, 19(8):2527–2537, November 2011.

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J.I. Marin-Hurtado, D.N. Parikh, and D.V. Anderson. Perceptually inspired noise-reduction method for binaural hearing aids. *Audio, Speech, and Language Processing, IEEE Transactions on*, 20(4):1372–1382, May 2012.

B. Gestner, Xiaoli Ma, and D.V. Anderson. Incremental lattice reduction: Motivation, theory, and practical implementation. *Wireless Communications, IEEE Transactions on*, 11(1):188–198, January 2012.

A.A. Kressner, D.V. Anderson, and C.J. Rozell. Evaluating the generalization of the hearing aid speech quality index (hasqi). *Audio, Speech, and Language Processing, IEEE Transactions on*, 21(2):407–415, February 2013.

S. Ramakrishnan, A. Basu, Leung Kin Chiu, J. Hasler, D. Anderson, and S. Brink. Speech processing on a reconfigurable analog platform. *Very Large Scale Integration (VLSI) Systems, IEEE Transactions on*, 22(2):430–433, Feb 2014.

Nashlie H Sephus, Aaron D Lanterman, and David V Anderson. Modulation spectral features: In pursuit of invariant representations of music with application to unsupervised source identification. *Journal of New Music Research*, 44(1):58–70, 2015.

Jinwoo Kang, David V. Anderson, and Monson H. Hayes. Face recognition for vehicle personalization with near infrared frame differencing. *IEEE Transactions on Consumer Electronics*, 62(3):316–324, August 2016.

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David V. Anderson, Richard W. Harris, and Douglas M. Chabries. Evaluation of a hearing compensation algorithm. In *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing*, volume 5, pages 3531–3533, Detroit, May 1995.

Douglas M. Chabries, David V. Anderson, Thomas G. Stockham, Jr., and Richard W. Christiansen. Application of a human auditory model to loudness perception and hearing compensation. In *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing*, volume 5, pages 3527–3530, Detroit, May 1995.

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David V. Anderson, Thomas P. Barnwell, Monson H. Hayes III, and Joel R. Jackson. Effective and efficient distance learning over the internet: Implementation of an on-line DSP course. In *Proc. International Conference on Engineering Education*, Taiwan, August 2000.

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Monson H. Hayes III, Joel R. Jackson, and David V. Anderson. Producing effective internet courses with *in*Fusion. In *Proceedings Learning '00*, Madrid, Spain, October 2000.

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David V. Anderson and Paul Hasler. Cooperative analog/digital signal processing. In *World Conference on Systemics, Cybernetics, and Informatics*, Orlando, FL, July 2001. *Invited Paper, Best Paper Award.*

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Joel R. Jackson, Thomas P. Barnwell, Douglas B. Williams, Monson H. Hayes III, David V. Anderson, and Ronald W. Schafer. Online DSP education: DSP for practicing engineers. In *American Society for Engineering Education Annual Conference*, Albuquerque, NM, June 2001.

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Paul Smith, Matt Kucic, Rich Ellis, Paul Hasler, and David V. Anderson. Cepstrum frequency encoding in analog floating-gate circuitry. In *Proceedings*

of the IEEE International Symposium on Circuits and Systems, volume IV, pages 671–674, Phoenix, AZ, May 2002.

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Heejong Yoo, David V. Anderson, and Paul Hasler. Continuous–time audio noise suppression and real-time implementation. In *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing*, volume IV, pages 3980–3983, Orlando, FL, May 2002.

Richard Ellis, Heejong Yoo, and David V. Anderson. An analog floating-gate IC for audio noise suppression. In *Proceedings of the International Symposium on Circuits and Systems*, volume II, pages 728–31, Phoenix, AZ, May 2002. Invited Paper.

Paul Hasler, Paul Smith, Richard Ellis, David Graham, and David V. Anderson. Biologically inspired auditory sensing system interfaces on a chip. In *2002 IEEE Sensors Conference*, Orlando, FL, June 2002. *Invited Paper, nominated for Best Paper of Conference*.

Paul Hasler, Abhishek Bandyopadhyay, and David V. Anderson. Low–power analog image processing using transform imagers. In *IEEE Midwest Circuits and Systems*, Tulsa, OK, August 2002.

Paul Hasler, Paul Smith, Chris Duffy, Christal Gordon, Jeff Dugger, and David Anderson. A floating-gate vector-quantizer. In *IEEE Midwest Circuits and Systems*, Tulsa, OK, August 2002.

Tyson S. Hall, Paul Hasler, and David V. Anderson. Field-programmable analog arrays: A floating-gate approach. In *12th International Conference on Field Programmable Logic and Applications*, Montpellier, France, September 2002.

Paul Hasler, Abhishek Bandyopadhyay, and David Anderson. Low-power analog image processing using transform imagers. In *Digital Signal Processing Workshop*, pages 333–338, Pine Mountain, Georgia, October 2002.

David Anderson, Paul Hasler, Rich Ellis, Heejong Yoo, David Graham, and Mat Hans. A low–power, continuous–time system for audio noise suppression and a VLSI implementation. In *Digital Signal Processing Workshop*, pages 327–332, Pine Mountain, Georgia, October 2002.

Tyson S. Hall and David V. Anderson. From algorithms to gates: Developing a pedagogical framework for teaching DSP hardware design. In *Signal Processing Education Workshop*, pages 157–161, Pine Mountain, Georgia, October 2002.

P. Spencer Whitehead, David V. Anderson, and Mark A. Clements. Adaptive acoustic noise suppression for speech enhancement. In *Proceedings 2003*

International Conference on Multimedia and Expo, volume 1, pages 565–568, Baltimore, MD, June 2003.

Cenk Demiroglu and David V. Anderson. Noise robust digit recognition with missing frames. In *8th European Conference on Speech Communication and Technology*, pages 2165–2168, Geneva, Switzerland, September 2003.

Venkatesh Krishnan and David V. Anderson. Robust jointly optimized multistage vector quantization for speech coding. In *8th European Conference on Speech Communication and Technology*, pages 1093–1096, Geneva, Switzerland, September 2003.

Sunil D. Kamath and David V. Anderson. Signal processing in digital and floating-gate analog circuits; design trade-offs. In *Proceedings of the Asilomar Conference on Circuits, Systems, and Computers*, Pacific Grove, CA, November 2003.

Heejong Yoo, David V. Anderson, and Paul Hasler. On delay structures for the analog adaptive filters with long filter taps. In *Proceedings of the Asilomar Conference on Circuits, Systems, and Computers*, Pacific Grove, CA, November 2003.

Daniel Allred, Venkatesh Krishnan, Walter Huang, and David V. Anderson. Implementation of an LMS adaptive filter on an FPGA employing multiplexed multiplier architecture. In *Proceedings of the Asilomar Conference on Circuits, Systems, and Computers*, Pacific Grove, CA, November 2003.

Sourabh Ravindran, Cenk Demiroglu, and David V. Anderson. Speech recognition using filter bank features. In *Proceedings of the Asilomar Conference on Circuits, Systems, and Computers*, Pacific Grove, CA, November 2003.

Thomas Barnwell III, Mark Clements, David Anderson, Elliot Moore, Matthew Lee, Erdem Ertan, Venkatesh Krishnan, Woosuk Choi, James Hu, Cenk Demiroglu, Spencer Whitehead, and Adriane Durey. Low bit-rate coding of speech in harsh conditions using non-acoustic auxiliary devices. In *Special Workshop in Maui: Lectures by the Masters in Signal Processing*, Maui, HI, January 2004.

Michael Healy, Sourabh Ravindran, and David V. Anderson. Effects of varying parameters in asymmetric adaboost on the accuracy of a cascade audio classifier. In *IEEE SoutheastCon 2004*, Greensboro, NC, March 2004.

Tyson S. Hall, Christopher M. Twigg, Paul Hasler, and David V. Anderson. Developing large-scale field-programmable analog arrays. In *11th Reconfigurable Architectures Workshop (RAW 2004), 18th International Parallel and Distributed Processing Symposium*, pages 142–147, Santa Fé, NM, April 2004.

Tyson S. Hall, Christopher M. Twigg, Paul Hasler, and David V. Anderson. Application performance of elements in a floating-gate FPAA. In *Proceedings of*

the International Symposium on Circuits and Systems, Vancouver, Canada, May 2004.

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Cenk Demiroglu and David V. Anderson. Two-sensor noise-robust ASR with missing frames for Aurora2 task. In *Proceedings of the International Symposium on Circuits and Systems*, Vancouver, Canada, May 2004.

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Daniel J. Allred, Heejong Yoo, Venkatesh Krishnan, and David V. Anderson. A novel high performance distributed arithmetic adaptive filter implementation on an FPGA. In *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing*, Montreal, Canada, May 2004.

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Cenk Demiroglu and David V. Anderson. A soft decision MMSE amplitude estimator as a noise preprocessor to speech coders using a glottal sensor. In *International Conference on Spoken Language Processing*, Jeju, Korea, October 2004.

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Rongqiang Hu and David V. Anderson. Improved perceptually inspired speech enhancement using a psychoacoustic model. In *Proceedings of the Asilomar Conference on Circuits, Systems, and Computers*, Pacific Grove, CA, November 2004.

Cenk Demiroglu, Sunil Kamath, David V. Anderson, Mark A. Clements, and Thomas P. Barnwell III. Segmentation based speech enhancement using auxiliary sensors. In *Proceedings of the Asilomar Conference on Circuits, Systems, and Computers*, Pacific Grove, CA, November 2004.

Teahyung Lee and David V. Anderson. The behavioral simulation results of the optical flow estimation algorithm for CADSP system design. In *Proceedings of the Asilomar Conference on Circuits, Systems, and Computers*, Pacific Grove, CA, November 2004.

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I. Faik Baskaya, Sasank Reddy, Sung Kyu Lim, and David Anderson. Hierarchical placement for large-scale FPAA. In *International Conference on Field Programmable Logic and Applications*, pages 421–426, Tampere, Finland, August 2005.

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Jungwon Lee, Teahyung Lee, and David V. Anderson. Improved wavelet-based embedded image coding using a dynamic index reordering vector quantizer. In *Data Compression Conference*, page 530, Snowbird, UT, USA, March 2008.

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Harry B. Marr, Jason George, David V. Anderson, and Paul Hasler. Increased energy efficiency and reliability of ultra-low power arithmetic. In *Proceedings of the IEEE Midwest Symposium on Circuits and Systems*, pages 366–369, August 2008.

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Brian Gestner, Wei Zhang, Xiaoli Ma, and David V. Anderson. VLSI implementation of an effective lattice reduction algorithm with fixed-point considerations. In *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing*, Taipei, Taiwan, April 2009.

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RR Curtin, WB March, P Ram, DV Anderson, AG Gray, and CLI Jr. Tree-independent dual-tree algorithms. In *2013 IEEE International Conference on Machine Learning*, Apr 2013.

AA Kressner, DV Anderson, and CJ Rozell. A novel binary mask estimator based on sparse approximation. In *2013 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pages 7497–7501, 2013.

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V Duangudom and DV Anderson. Identifying salient sounds using dual-task experiments. In *IEEE Workshop on Applications of Signal Processing to Audio and Acoustics*, 2013.

CM Chu, DV Anderson, and IEEE. Likelihood codebook reordering vector quantization. In *2013 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pages 5114–5117, 2013.

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IA Khan, DV Anderson, and CF Barnes. Classification using residual vector quantization with markov-bayesian structure. In *Data Compression Conference*. Snowbird, Utah, Apr 2015.

Muhammad Rizwan and David V Anderson. Speaker adaptation using speaker similarity score on dnn features. In *2015 IEEE 14th International Conference on Machine Learning and Applications (ICMLA)*, pages 877–882. IEEE, 2015.

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B. M. Whitaker and D. V. Anderson. Heart sound classification via sparse coding. In *2016 Computing in Cardiology Conference (CinC)*, pages 805–808, September 2016.

C. F. Cheng, A. Rashidi, M. A. Davenport, D. V. Anderson, and C. A. Sabillon. Hardware and software requirements for acoustical monitoring of construction jobsites. In *Proc. Int. Workshop on Computing in Civil Engineering 2017*, 2017.

B. O. Odelowo and D. V. Anderson. Speech enhancement using extreme learning machines. In *2017 IEEE Workshop on Applications of Signal Processing to Audio and Acoustics (WASPAA)*, pages 200–204, October 2017.

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C. A. Sabillon, A. Rashidi, B. Samanta, C. F. Cheng, M. A. Davenport, and D. V. Anderson. A productivity forecasting system for construction cyclic operations using audio signals and a Bayesian approach. In *to appear in Construction Research Congress (CRC)*, April 2018.

Conference Presentations without Proceedings

David V. Anderson and Mark A. Clements. Noise suppression in speech using multi-resolution sinusoidal modeling. presented at the Fall 1998 Meeting of the Acoustical Society of America, Norfolk, VA.

David V. Anderson, Douglas Chabries, and Richard W. Christiansen. Time constants in multi-band compressive gain hearing aids. In *International Hearing Aid Research Conference*, Lake Tahoe, CA, August 2000.

David V. Anderson, Phil Spencer Whitehead, and Mark A. Clements. Acoustic noise suppression for speech enhancement. presented at the Fall 2001 Meeting of the Acoustical Society of America, Ft. Lauderdale, FL, October 2001.

David V. Anderson. Fast dynamic range compression method for multichannel hearing aids. presented at the 143rd Meeting of the Acoustical Society of America, Pittsburgh, Pennsylvania, June 2002.

I. Faik Baskaya, Sasank Reddy, Tyson Hall, David V. Anderson, Paul Hasler, and Sung Kyu Lim. Analog circuit modeling and clustering for large scale FPAA. presented at the Design Automation and Test Conference, May 2004.

Technical Reports

Heejong Yoo, Rich Ellis, David V. Anderson, Paul Hasler, David W. Graham, and Mat Hans. Continuous–time audio noise suppression and real–time implementation. Technical Report HPL-2002-311, HP Labs, November 2002. available at http://www.hpl.hp.com/techreports.

André van Schaik, David Anderson, Steven Greenberg, Malcom Slaney, et al. Final report—chapter on audio projects. Technical report, Telluride Workshop on Neuromorphic Engineering, Telluride, CO, July 2003.

Malcolm Slaney, David V. Anderson, André van Schaik, et al. Final report—chapter on audio projects. Technical report, Telluride Workshop on Neuromorphic Engineering, Telluride, CO, July 2004.

Seminar Presentations

David V. Anderson, Monson H. Hayes III, and Joel Jackson. Streaming multimedia course development. Invited seminar at Virginia Tech, December 2000.

David V. Anderson. Cooperative analog/digital signal processing. Georgia Tech Analog Consortium Industry Review, March 2001.

David V. Anderson. Analog signal processing in a digital world. Georgia Tech Analog Consortium Industry Review, March 2002.

David V. Anderson. Analog and signal processing. Georgia Tech Analog Consortium Industry Review, October 2003.

David V. Anderson. Cooperative analog/digital signal processing. Invited speaker: IEEE Georgia Tech Student Chapter meeting, March 2000.

Mat Hans and David V. Anderson. Sensor inputs for portable devices. Invited speaker: IEEE Georgia Tech Student Chapter meeting, February 2002.

David V. Anderson. Bucking the trend. Keynote speaker at HKN Honor Society induction, April 2002.

David V. Anderson. Prototyping cooperative analog-digital signal processing for auditory applications. Telluride Workshop on Neuromorphic Engineering, July 2003.

David V. Anderson. Neuro-inspired audio processing. Telluride Workshop on Neuromorphic Engineering, July 2004.

David V. Anderson. Signal processing trends. Invited speaker: Korea University, May 2005.

David V. Anderson. Low-power signal processing trends. Invited speaker: Johns Hopkins University, November 2005.

David V. Anderson. Signal processing with analog VLSI. Invited speaker: State University of New York – Stony Brook, January 2006.

David V. Anderson. Neuro-inspired signal processing. Telluride Workshop on Neuromorphic Engineering, July 2005.

David V. Anderson. Audio signal enhancement. Telluride Workshop on Neuromorphic Engineering, July 2006.

David V. Anderson. Human perception and signal processing. Telluride Workshop on Neuromorphic Engineering, July 2008.

David V. Anderson. Bayesian probability in everyday life. Presentation to Autry Mill Middle School Math Classes, May 2009.

David V. Anderson. Multimedia signal processing. Invited speaker: Korea University, July 2009.

Patents

David V. Anderson, Kwan Truong, and Stephen McGrath. Adaptive filter featuring spectral gain smoothing and variable noise multiplier for noise reduction, and methods therefor. U.S. Patent no. 6,351,731, July 1999. Issued 2002.

David V. Anderson, Kwan Truong, and Stephen McGrath. Speech activity detector for use in noise reduction system, and methods therefor. U.S. Patent no. 6,453,285, July 1999. Issued 2002.

Jeffery Dugger, Tyson S. Hall, Paul Hasler, David V. Anderson, Paul D. Smith, Matthew R. Kucic, and Abhishek Bandyopadhyay. Floating-gate analog circuit. U.S. Patent no. 6,898.097, May 2005.

Daniel J. Allred, David V. Anderson, Walter G. Huang, Venkatesh Krishnan, and Heejong Yoo. Distributed arithmetic adaptive filter and method. U.S. Patent application no. 20050201457, September 2005.

Philomena Cleopha Brady, Haw-Jing Lo, Guillermo Jose Serrano, Farhan Adil, Matthew R. Kucic, Paul Hasler, David V. Anderson, and Angelo Pereira. Floating-gate reference circuit. U.S. Patent no. 7,034,603, April 2006.

Erhan Ozalevli, Paul Hasler, David V. Anderson, and Walter G. Huang. Reconfigurable mixed-signal VLSI implementation of distributed arithmetic. U.S. Patent no. 7,348,909, March 2008.

Richard T. Ellis, Heejong Yoo, David W. Graham, Paul E. Hasler, and David V. Anderson. Analog audio signal enhancement system using a noise suppression algorithm. U.S. Patent no. 7,590,250, September 2009.

David Verl Anderson, Brian Gestner, and Xiaoli Ma. Incremental lattice reduction systems and methods. U.S. Patent no. 8,948,318 B2, February 2015.

Other Scholarly and Teaching Activities

Undergraduate Research

- Supervised over 100 undergraduate research projects.

Graduate Course Development

- Human Perception and Signal Processing: Advanced Topics in Signal Processing, ECE 7252. The objective of this course is to explore human-centric applications of signal processing. Students learn about compression standards such as MPEG audio and video, perceptually relevant error measures, subjective and objective quality measures, hearing impairments and compensation, signal enhancement, and current research topics in signal processing and human perception.

Short Course Development

- "Digital Signal Processing for Practicing Engineers" - a 12-week on-line course delivered: February 2000, ongoing approximately twice per year.
- "Streaming Multi-Media Production" One-day course delivered: May 2000
- "Finite-Precision Signal Processing" Four-day course delivered: Spring 2007, Summer 2007, Spring 2009.
- "Applications of Psychoacoustics to Signal Processing" One-day tutorial delivered: Spring 2009

Grants and Contracts

Foundation Gifts

	Sponsor	Title	Dates	$ Funded
1.	Google	Fast Analysis of High-dimensional Data	10/07	$75,000
		With Alex Gray in CoC		
2.	Google	Audio Saliency	10/07	$100,000
		With Alex Gray in CoC		
3.	National Semiconductor	Sound Classification Circuits Research	9/05–	$125,000
4.	IDT Corporation	FFT Circuits Research	10/06	$30,000

As Principal and Co-principal Investigator

	Sponsor	Title	Dates	$ Funded	Contribution
1.	NSF	High Density Analog Computing Arrays	9/00–8/04	$443,000	40%
		CoPI — PI: P. Hasler			
2.	Georgia Tech Broadband Institute	Blind Source Separation for Audio	7/01–6/02	$26,000	100%
3.	Georgia Tech Broadband Institute	Audio Classification	7/02–6/03	$26,000	100%
4.	Georgia Tech Broadband Institute	Audio Classification	7/03–6/04	$20,000	100%
5.	GVU Center	Auditory Scene Analysis	7/02–6/03	$16,170	100%
6.	DARPA	Focal–Plane Image Enhancement	8/02–2/04	$375,000	40%
		CoPI — PI: P. Hasler			
7.	DARPA	Focal–Plane Image Processing	7/04–7/06	$900,000	40%

		CoPI — PI: P. Hasler			
8.	DARPA	Improved Speech Analysis, Coding, and Enhancement using Microradars	10/02–3/06	$2,275,955	40%
		CoPI — PI: M. Clements, other CoPI's: T. Barnwell, G. Whitley			
9.	NSF	CAREER: Ultra-Low Power Programmable Analog Signal Processing Systems	6/04–5/09	$400,000	100%
10.	CIA	Low–power Array Processing	6/04–7/05	$383,200	100%
11.	NSF	Bringing Low Power Reconfigurable Analog Signal Processing to Embedded Systems	9/04–9/07	$240,000	20%
		CoPI — PI: S. K. Lim, other CoPI: P. Hasler			
12.	NSF	Probabilistic CMOS Computing and Applications	8/07-8/10	$762,000	100%
13.	Raytheon	Machine Learning of Visual Features	5/09–5/10	$85,000	50%
		PI — CoPI: A. Gray			
14.	National Semiconductor	Hearing Aid Audio Processing	5/09–6/12	$150,000	100%
15.	National Semiconductor	Speaker Driver Sound Enhancement	11/09–12/10	$50,000	100%
16.	Army Research Office	Realizing Lattice-Reduction-Based Detectors for High-Rate Wireless Communications	8/11–6/12	$50,000	50%
		CoPI — PI: X. Ma			
17.	NSF	I-CORPS	7/12–6/13	$50,000	100%
18.	Walmart Foundation	Craft with Pride: Development and Deployment of Disruptive Manufacturing	9/14–8/16	$2,959,656	10%
		CoPI — PI: S. Jayaraman			

As Investigator

	Sponsor	Title	Dates	$ Funded	Contribution
1.	Yamacraw	Embedded DSP Processing	8/99–6/03	–	Support for three students
2.	Georgia Electronic Design Center	Embedded DSP Processing	7/03–6/09	$70,000	100%
3.	Hewlett Packard	GT & HP Research Project Y2001	1/01–12/01	$275,000	30%
		Fellow Investigators: R. Schafer, J. Jackson, M. Hans			
4.	Yamacraw	Education–Short Course	1/01-6/01	$300,000	20%
		Fellow Investigator: T. Barnwell			
5.	Hewlett Packard	GT & HP Research Project Y2002	1/02–12/02	$275,000	30%
		Fellow Investigators: R. Schafer, J. Jackson, M. Hans			
6.	Hewlett Packard	GT & HP Research Project Y2003	1/03–12/03	$105,000	100%
7.	Hewlett Packard	GT & HP Research Project Y2004	1/04–12/04	$93,000	100%
8.	Hewlett Packard	GT & HP Research Project Y2005	1/05–12/05	$93,000	100%
9.	Georgia Tech Analog Consortium	Texas Instruments Fellows Program	8/01–12/02	—	Support for three students
10.	Georgia Tech Analog Consortium	Texas Instruments Fellows Program	1/03–present	—	Support for two students
11.	Texas Instruments	TI Leadership University	8/04–present		Support for one student

12.	Aware Home Research Initiative	Speaker Identification	7/01–12/01	—	Support for one student

Other Funding

- Received Georgia Tech Technology Fee Grant for class laboratory development: $29,490 (Fall 2002).
- Procured a donation of FPGA boards for use by twenty students in DSP Systems class (Summer 2002).
- Procured a donation of forty TI MSP430 development systems for use in senior design and research (Fall 2002).
- Institute for Neuromorphic Engineering Research Collaboration Network travel grant (funded by the NSF): $3,500 (Fall 2003)
- Institute for Neuromorphic Engineering Research Collaboration Network travel grant (funded by the NSF): $5,400 (Summer 2004)

CERTIFICATE OF SERVICE

The undersigned hereby certifies that on March 14, 2018, a true and correct copy of the foregoing:

EXPERT REPORT OF DAVID V. ANDERSON ON CLAIM CONSTRUCTION OF ASSERTED U.S. PATENT NO. 9,183,846

was served as follows:

☒ **[E-Mail]** By causing the above documents to be sent via electronic mail to the parties at the email addresses listed below. I am aware that service is presumed invalid if the email transmission is returned as undeliverable.

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